early indication that in the opening up of new lands the provision of adequate means of transport must precede the advent of the settler.

A connecting link between the Great Lakes and the Mississippi was necessary. An ancient outlet of Lake Michigan led to the Illinois River, which reaches the Mississippi near St. Louis, and so the State authorities, after overcoming many financial difficulties, eventually made the canal, which was opened in 1848.

Prof. Putnam details these early struggles, blames the "spoils system" for inefficient management and the consequent failure of the canal in later years, and pleads for the construction along the canal route of a waterway suitable for such ocean-going steamers as can at present reach Chicago and St. Louis. Both these cities have progressed in no small degree because they are terminals of the Illinois and Michigan navigation. Chicago in 1831 was a village; from 1848 to 1854 the population of the city rose from 20,035 to 74,500, and in 1870 it contained more than 300,000 inhabitants.

LETTERS TO THE EDITOR.

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Some Temperature Anomalies.

THE investigations conducted by Hann and others have yielded a complete explanation of the physical processes involved in the production of the Föhn, Chinook, and similar winds met with in various parts of the world—a warm, moist air current depositing its moisture and decreasing in temperature while ascending the windward slope of a mountain range, then on the lee side descending and becoming intensely dry and increasing greatly in temperature as a consequence of the increase of pressure during the descent. But in the British Isles, and no doubt in other regions similarly situated in the neighbourhood of a relatively warm ocean current, there are occasions—and they are by no means uncommon—when a mild, soft sea breeze produces some curious temperature anomalies, which, so far as I am aware, have not attracted the attention of meteorologists and physicists, and, consequently, are thus far without any adequate explanation. They visit this country and western Europe in all seasons, but they are more noticeable in the winter half of the year, because the change of temperature is then relatively much greater than in the normally warm seasons.

Although the feature is observed only with the wind from points between west and south, and perhaps most frequently from about W.S.W., it is far from being an invariable accompaniment of an air current from this direction. On theoretical grounds, and from our conception of the natural order of things, we expect a rise of temperature over this country with a wind coming from the warm region of the Azores and the Lower Atlantic—the increase greatest in the west, nearest the seat of the source of the warmth, then becoming less and less marked during the eastward translation of the air current across the land, so that the bracing east coast of Britain would still be markedly cooler than the west coast of Ireland. The remarkable fact, however, is that actually the exact contrary is the case, the arrival of the warm current producing an increase of temperature on the western coasts, but the increase becoming more and more decided over the cold land, until the temperature in the extreme east is considerably higher than it is on the western seaboard.

There is in the Meteorological Office publications—the Daily, Weekly, and Monthly Reports for many years past—an *embarras de richesses* of illustrations of this particular feature. An excellent example is afforded by our experience during February 23 of the past year. On the morning of that day we were placed between an anticyclone centred over the Bay of Biscay and low pressure extending across from Iceland to Norway, with the wind at W.S.W. from Shetland southward, and the air temperature already well in excess of the normal in all districts. Over the country generally the thermometer had remained as high as 45° to 51° through the preceding night. During the day, however, the rise of temperature was very slight in the west, while it increased decidedly with the eastward advance of the wind. In the accompanying map the afternoon maximum temperatures are seen to be below 50° along the shores of the Bristol and St. George's Channels, and 50° to 53° on the outer western coasts from the Hebrides down to Scilly. Over eastern Britain, on the other hand, the maxima were 58° and upwards, 60° being reached at Crathes and Geldeston, and 61° at Aberdeen and Halstead. These were about the same as the maxima registered at the Azores on previous days. Even in eastern Ireland 56° were registered in Down, and 58° in Waterford. The day's range of temperature was less than 5° in the west generally, 0° to 3° in several localities, but eastward it increased to more than 10° over the greater part of Scotland and in eastern England, and as much as 15° to 18° in the east of Scotland.

The day was marked by a little rain locally, the general weather being fair to cloudy or overcast, with little or no sunshine over a wide area, and where there was sunshine the temperature was not materially different from what it was in sunless localities. Banff had the best sunshine record, eight hours, with temperature 59°, Cambridge registering the same maximum with one and a half hours of sunshine, and Westminster without a ray of sunshine. There was some sea fog between Pembroke and the Channel Islands to account for the lower temperature records in that region.

This particular instance can be accepted as typical of what takes place on these occasions, but I must refer to one other case, because it is the most extraordinary within my long experience. There were many such during the abnormally stormy conditions which prevailed over the Atlantic in the winter of 1898–99 (see charts illustrating the weather of this period, Meteorological Office, Official No. 142). On February 10, 1899, when the greatest winter cold on record was being experienced in America, the temperature ranging down to −60° in Ontario and −61° in Montana, a south to south-west breeze brought to a great part of Europe unprecedented winter warmth. At Cahirciveen Observatory, on the Kerry coast, the thermometer mounted on that day to 54°. Thence eastward over a distance of at least 700 miles the following maxima were recorded:—56° at Scilly, 57° at Brest and Clifton, 61° at Jersey, 62° at Oxford, 66° in London, 69° at Paris, and 70½° at Liége and Verviers. Still further to the east, another 300 miles, and Berlin and Munich rose to 59°, the whole of central and southern Europe and as far east as the Caucasus experiencing a marked increase of temperature, but

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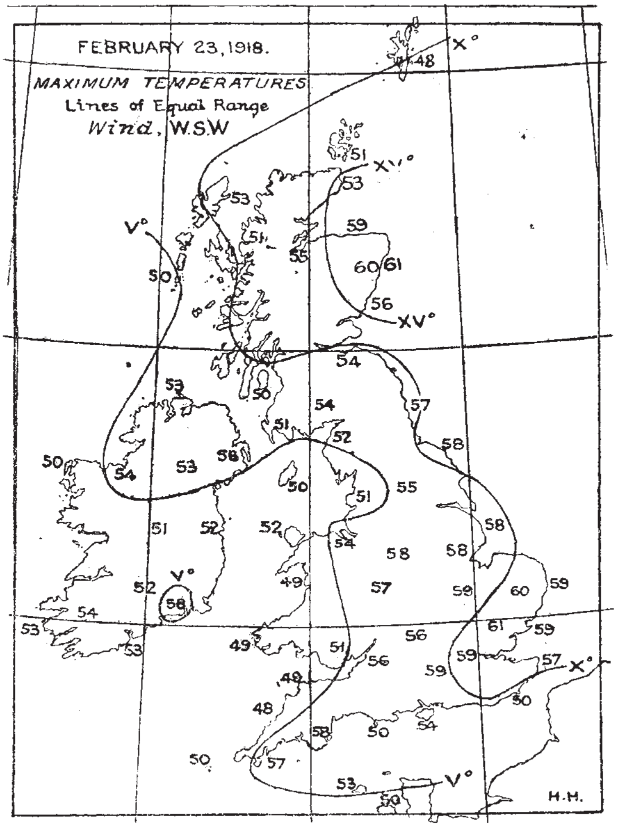
the warm wind did not affect Scotland and northern Europe. The Greenwich, Paris, and Brussels records (in the case of Paris extending back to the middle of the eighteenth century) disclose no other February maxima equal to those experienced on this occasion.

At high levels the crest of this remarkable heat-wave would seem to have lagged during the eastward advance, for at Davos Platz, at an altitude of more than 5000 ft., although the unprecedented February temperature of 53° was reached on the 10th, it was not until the 15th that the very extraordinary winter maximum of 63° was attained, and the same level was touched on the 19th. So exceptional was the warmth that the average maximum for the six days, 15th–20th, was as high as 61°, only one day being below 60°. Within a few days of each other Montana and Switzerland, in about the same latitude and at about the same elevation, had temperatures differing by 124°, from −61° in a N.W. land-wind to +63° in a S.W. sea-wind.



How are we to account for the noticeable accession of heat which these observations show takes place as the air spreads across the land further and further away from what we regard as the seat of origin of the warmth? Thus far, the only suggestion I have received has been that perhaps it will prove to be of the Föhn character—a descending current. There are difficulties in the way of accepting this view. In the first place, our south-westerly winds are ascending rather than descending currents. We might be able to show that winds from the Atlantic crossing mountainous western Scotland are of the Föhn character on reaching the east coast, but it is scarcely likely that a Scotch Föhn would bring to Aberdeen a February temperature of 64° (more than 20° above the normal), as on the 22nd in 1897. Such eminences as exist in the south are too far distant to windward and of too moderate altitudes to produce any Föhn effect in London and the Eastern Counties, and across northern France, Belgium, and Prussia. The Davos Platz experience does not support the Föhn argument. It should be borne in mind that the phenomenon with which we are now dealing manifests itself at sea-level on the extreme western coasts before any high land is reached, and thenceforward there is a progressive accession of temperature, regardless of mountain and valley, sunshine and dullness, rainfall and dryness, thus placing the subject on a very different footing from that of the Föhn.

Now that the upper-air conditions are being so closely observed, daily and almost hourly, it should be possible at no distant date to accumulate sufficient evidence to make a special investigation of the circumstances, above and below, which combine to produce the temperature effects described above, and thus to enable us to arrive at the correct explanation of their causation and to predict their occurrence.

9 The Grove, Isleworth. Hy. Harries.

The Perception of Sound.

Before the discussion on the physiology of the internal ear is closed, it might be well to direct attention to a point in connection with the supposed necessity of the auditory nerve transmitting the very large number of impulses corresponding with the vibrations constituting musical tones.

Although the pitch of a particular tone is, say, 640 d.v. per second, it is not necessary that, in order to recognise it, we should listen to that tone for a whole second of time. Prof. McKendrick many years ago demonstrated that we could recognise as distinct from its predecessor and successor a note in a musical composition if it were listened to for only 1/64th of a second. In such a case this would mean that only ten condensations would affect the organ of Corti, and presumably only ten nerve-impulses ascend the auditory nerve. Prof. McKendrick, with whom it was my privilege to be associated at that time, studied the surface of the wax-cylinder records of musical compositions recorded for reproduction by the phonograph.

Since the speed of rotation of the cylinder was known, the number of impressions in the wax corresponding with each of a series of tones could be ascertained; and it was found that, in order to recognise any given tone, it was only necessary to "hear" that tone for not longer than 1/64th of a second. If I remember correctly, a shorter period still was in some cases demonstrated to be sufficient.

Now if, say, 1/100th of a second is long enough, it is clear that the hearing of quite high tones could be effected by a comparatively small number of vibrations or disturbances in the internal ear and of subsequent impulses in the nerve.

A tone of 2000 d.v. per second could be recognised by 20 impulses, and one of 10,000 pitch by 100, and so on. Apparently the auditory nerve is competent to transmit individual impulses of that order of frequency.

It seems to me that attention to this point will make the problem of hearing rather simpler than at first it appears by removing the necessity for believing that, in order to appreciate a note of a given pitch, we require to have the auditory nerve transmitting the large number of impulses corresponding with the large number of vibrations which, according to physicists, is the pitch or number *per second* of that note. In other words the different tones in a musical composition follow one another with such rapidity that

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